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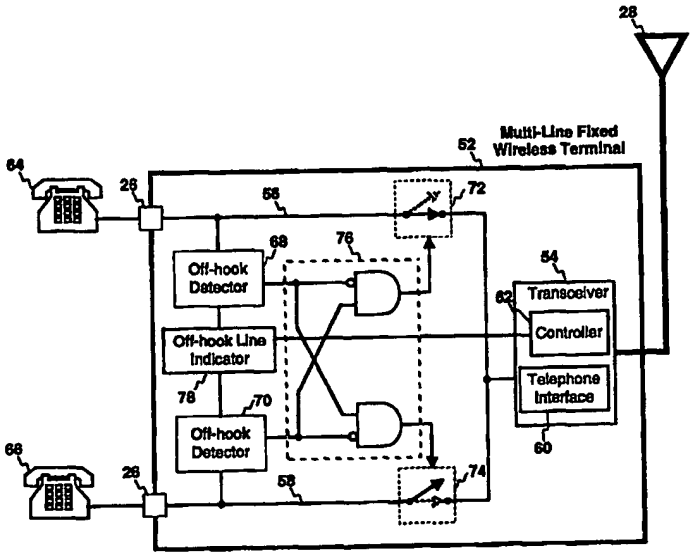

(57) Abstract

In a method and system in a telecommunications system (50) for privately operating multiple terminal equipment units (64 and 66) using a single transceiver (54) in a fixed wireless terminal (52 and 72), an off–hook condition is detected (68, 70, and 202) in a first telephone or terminal equipment unit (64) coupled to the transceiver (54). In response to detecting the off–hook condition, a second terminal equipment unit (66) is uncoupled (74 and 208) from the transceiver (54), so that the first terminal equipment unit (64) is privately communicating with the transceiver (54) with respect to the second terminal equipment unit (66). An off–hook line indicator (78) may be used to identify the terminal equipment unit communicating via the transceiver (54) for recording billing information (206).

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METHOD AND SYSTEM FOR OPERATING MULTIPLE TERMINAL EQUIPMENT UNITS USING A FIXED WIRELESS TERMINAL

Cross-Reference to Related Application

The present application is related to U.S. Patent Application Serial No. 08/808,279, entitled "Method and System for Operating Multiple Terminal Equipment Units Using a Fixed Wireless Terminal", Attorney's Docket No. CE04449N, filed of even date herewith, and assigned to the assignee herein and which is incorporated herein by reference.

Field of the Invention

The present invention relates generally to a wireless telecommunications system, and more particularly to the operation of fixed wireless terminals in a wireless communications system.

Background of the Invention

In many parts of the world, it is expensive or difficult to run copper wire or fiber optic cable to homes and businesses to provide local phone service. One way to avoid the cost of stringing cable is to implement a wireless local loop telephone system.

In a wireless local loop system, telephones and other terminal equipment at the customer's site is connected to a fixed wireless terminal (FWT). The fixed wireless terminal communicates with the public switched telephone network (PSTN) through a wireless or radio link. With a wireless local loop system, basic telephone service can be provided to customers who would not otherwise have access to telecommunications services at a fraction of the costs of a traditional wire line infrastructure. Wireless local loop systems provide telecommunications system operators with the benefits of rapid deployment, large coverage area, large capacity, and lower operating

and maintenance costs. With a wireless local loop system, digital wireless telephone networks may be deployed rapidly and economically in developing countries which lack sufficient land-line infrastructure.

With reference to **FIG. 1**, there is depicted a wireless local loop communications system **20**. As shown, terminal equipment unit **22** is coupled to fixed wireless terminal **24** at input port **26**. Terminal equipment unit **22** may be a telephone, fax machine, modem, or other customer provided equipment, or customer premise equipment (CPE). Input port **26** is typically implemented with an RJ-11 jack, which may be used to connect a twisted-pair copper cable between terminal equipment unit **22** and fixed wireless terminal **24**.

Fixed wireless terminal **24** is coupled to antenna **28** for transmitting radio frequency signal **30** to base station **32**. Radio frequency **30** ordinarily conforms to an air interface standard, such as the industry standard IS-95 for code division multiple access (CDMA) cellular communications systems. After receiving signals from fixed wireless terminal **24**, base station **32** ultimately communicates a user's voice or data signals to the public switched telephone network **34** so that a customer using telephone **22** may place a call to other telephones connected to the public switched telephone network.

Fixed wireless terminal **24** is referred to as "fixed" because it is ordinarily mounted in a convenient location in a building or home so that it remains fixed in relation to the location of base station **32**.

However, even when the costs of telephone infrastructure is reduced by using wireless communications, providing telephone service in some areas may still be too expensive or economically unfeasible. To reduce costs, it has been proposed that more than one telephone be connected to the telephone interface at input port **26** in order to serve more than one telephone system customer. The problem with this cost-saving solution is that the customers connected

to the fixed wireless terminal have no privacy with respect to the others connected to the same terminal. If one customer is using the telephone, other customers on the terminal may listen to the conversation by merely picking up their telephone.

In addition to the privacy problem, the telephone system operator cannot distinguish a call initiated by one customer from one initiated by another. This means that if one customer connected to the FWT makes a long distance call, or incurs a cost associated with some other telephone service, the telephone system operator cannot determine which customer to charge for the service. With so many services being purchased by billing a customer through their phone bill, not being able to determine which customer purchased a service is an important problem to be solved.

Therefore, a need exists for an improved method and system for providing wireless local loop service to customers more efficiently with a lower cost per telephone line.

Brief Description of the Drawings

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objects, and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

FIG. 1 depicts a wireless local loop telecommunications system in accordance with the prior art;

FIG. 2 depicts a wireless local loop telecommunications system in accordance with the method and system of the present invention;

FIG. 3 depicts a high-level block diagram of a multi-line fixed wireless terminal in accordance with the method and system of the present invention;

FIG. 4 is a high-level block diagram of a multi-line adapter used in conjunction with a fixed wireless terminal in accordance with the method and system of the present invention; and

FIG. 5 is high-level logical flowchart that illustrates the operation of the method and system of the present invention.

Detailed Description of the Invention

With reference now to FIG. 2, there is depicted wireless local loop telecommunications system 50 in accordance with the method and system of the present invention. As illustrated, a plurality of terminal equipment units 22 are coupled to multi-line fixed wireless terminal 52 at input ports 26. As mentioned above, terminal equipment units 22 may be a telephone, a fax machine, a computer, a modem, or other customer provided equipment designed to interface with a typical POTS (Plain Old Telephone Service) subscriber loop. In a preferred embodiment, input port 26 is implemented with an RJ-11-type modular jack which is commonly used by many phone companies. In other embodiments, port 26 may be implemented with other jacks from the RJ family of jacks registered with the FCC (Federal Communications Commission), such as RJ-12 and RJ-45 jacks, or with other types of connectors. Port 26 may also be implemented with any technology for bidirectionally coupling signals or data between terminal equipment units 22 and multi-line fixed wireless terminal 52.

Multi-line fixed wireless terminal 52 transmits voice or data signals from antenna 28 by a radio frequency signal 30. Signal 30, which ordinarily conforms to an industry standard such as IS-95 for a CDMA communications system, may then be received at base station 32 and coupled to public switched telephone network 34 through, in a preferred embodiment, standard cellular infrastructure equipment.

Thus, the present invention further reduces the infrastructure cost per telephone customer by sharing the radio frequency transceiver resource while maintaining customer privacy and the capability for the

telephone system operator to collect customer billing information for charging services to a particular customer.

With reference now to **FIG. 3**, there is depicted a more detailed block diagram of multi-line fixed wireless terminal **52** in accordance with the method and system of the present invention. As shown, multiple terminal equipment units **22** are coupled to multi-line fixed wireless terminal **52** at input ports **26**. Signals passing through input ports **26** are coupled to transceiver **54** by communication circuits **56** and **58**. Transceiver **54** is preferably implemented using one of the known standard air interfaces for cellular communications systems, such as, but not limited to, the air interface standards promulgated by the TIA (Telecommunications Industries Association).

In one embodiment of the present invention transceiver **54** includes telephone interface **60** which provides a POTS subscriber loop interface for complying with communication circuits **56** and **58**.

Additionally, transceiver **54** may include controller **62** for translating signal protocol between the air interface protocol used by transceiver **54** and the telephone system provided by telephone interface **60**. For example, controller **62** may initiate a system ready indication, such as a dial tone signal, at telephone interface **60** in response to a terminal equipment unit **22** going into an off-hook condition. And telephone interface **60** may receive DTMF (Dual Tone Multi Frequency) signals from terminal equipment unit **22** and use controller **62** to translate such DTMF signals into commands that receiver **54** may send requested telephone number to public switched telephone network **30** via radio frequency signals **30**. Controller **62** may also provide such functions as transmitting an identification number for multi-line fixed wireless terminal **52** so that the wireless local telecommunications system operator may properly bill the customer for system access, long distance calls, or other telecommunications services.

According to an important aspect of the present invention, privacy between terminal equipment is provided by disconnecting terminal equipment unit 66 when terminal equipment unit 64 goes off-hook, and vice versa. In order to detect an off-hook conditioned in terminal equipment unit 64 and 66, off-hook detector 68 monitors the condition of terminal equipment unit 64 and off-hook detector 70 monitors the condition of terminal equipment unit 66. Off-hook detectors 68 and 70 are preferably implemented with either a current or a voltage detection circuit coupled to communications circuits 56 and 58.

In response to signals output by off-hook detectors 68 and 70, switches 72 and 74 are used to connect or disconnect terminal units 64 and 66, respectively, with transceiver 54. Switches 72 and 74 are preferably implemented with low power relays or solid state switches.

Control circuit 76 may be used to couple signals from off-hook detector 68 and 70 with switches 72 and 74. Control circuit 76 detects which terminal equipment unit went off-hook first and produces a signal that opens the switch in the communication circuit of the other telephone equipment units so that the first telephone to go off-hook seizes a private communication circuit between the off-hook terminal equipment unit and transceiver 54. Once a terminal equipment unit goes off-hook, all other terminal equipment units are disconnected from transceiver 54. As shown in FIG. 3, a simple connection of logic gates may be used to provide this privacy of insuring that only one communications circuit has access to transceiver 54, and that terminal equipment units are not coupled to the off-hook communications circuit.

In order to provide billing information to the wireless local loop telecommunications system operator, multi-line fixed wireless terminal 52 must determine which terminal equipment unit has seized transceiver 54. To perform this function, off-hook line indicator

78 produces a signal that indicates whether terminal equipment unit 64 or terminal equipment unit 66 is in an off-hook condition. This signal indicating which line is off-hook is coupled to transceiver 54 so that it may be properly formatted by controller 62 and communicated to base station 32 by an antenna 28 and radio frequency signal 30.

In the simple case of a two-line fixed wireless terminal, off-hook line indicator 78 may be implemented with a single binary bit of information, or a line polarity condition, that distinguishes between terminal equipment 64 being off-hook and terminal equipment unit 66 being off-hook.

A more advanced scheme for communicating such billing information may use a serial interface which passes a signal that uniquely identifies the off-hook terminal equipment unit. This serial interface may use in-band signals, such as DTMF (Dual Tone Multi Frequency) signals or modulated modem data, or use out-of-band signals, such as RS-232 signals, IEEE 488 signals, or the like. A parallel interface may also be used to communicate billing information.

As described above in reference to **FIG. 3**, the multi-line fixed wireless terminal may be implemented in a single enclosure. In an alternative embodiment of the present invention shown in **FIG. 4**, a multi-line adapter 90 may be used to convert a single-line fixed wireless terminal 92 so that it functions as a multi-line fixed wireless terminal. As shown in **FIG. 4**, multi-line adapter 90 includes input ports 26 for connecting terminal equipment units 64 and 66. Communications circuits 56 and 58 couple input ports 26 to output port 94. Off-hook detectors 68 and 70 are coupled to communication circuits 56 and 58, respectively, for detecting off-hook conditions in terminal equipment units 64 and 66, respectively. Output signals from off-hook detectors 68 and 70 are used to control switches 72 and 74 in accordance with signals produced by control circuit 76. Off-hook line indicator 78 produces a signal distinguishing an off-hook condition at terminal

equipment unit 64 and an off-hook condition at terminal equipment unit 66. This line-indicating signal may be coupled to controller 62 in fixed wireless terminal 92 via output port 94.

While the embodiments of the present invention shown in FIGs. 3 and 4 show only two-lines of telephone service per transceiver, the method and system of the present invention may be used to provide N number of telephone lines per transceiver 54 where N is limited by the percent blocking required by the telephone system operator. If N number of lines are provided, the N number of off-hook detectors may be used to control N number of switches coupled in series with N number of communication circuits. A control circuit similar to Control circuit 76 may be used to provide signals to disconnect all terminal equipment units that remain on-hook after an off-hook terminal equipment unit has seized telephone interface 60 in transceiver 54. Similarly, off-hook line indicator 78 may be used to sense signals from the N number of off-hook detectors to provide a signal that indicates which one of the N number of terminal equipment units has seized the local loop.

Referring now to FIG. 5, there is depicted a high-level logic flowchart that illustrates the operation of the method and system of the present invention. As illustrated, the process begins at block 200 and thereafter passes to block 202 wherein the process determines whether or not a user terminal equipment unit has gone into an off-hook condition. If no users are off-hook, the process connects all users via their respective communication circuits to the transceiver, as illustrated at block 204. All users are initially connected so that the first user off-hook immediately receives a system ready indication, such as a dial tone, and the off-hook detector may sense current in the current loop. The process then iteratively loops from block 202 to block 204 as the process waits for a terminal equipment unit to enter an off-hook condition.

If a user has gone into an off-hook condition, the process identifies each connected terminal equipment unit as either an on-hook user or an off-hook user, as depicted at block 206. It is important to identify the off-hook user so that billing information may be recorded and transferred to a billing office where users are charged for services purchased through the telephone. Such services include long distance service, calls to a "900 number" or similar caller-pays exchange, or other such services. Identifying the off-hook line may also be important for providing data to a caller ID system.

Thereafter, the process disconnects all on-hook users from the transceiver, as illustrated at block 208. This may be implemented by opening a switch in a communications circuit between an input port for the on-hook subscriber and the transceiver, as described above with reference to FIGs. 3 and 4.

After disconnecting on-hook users, the process determines whether or not an on-hook user has entered an off-hook state, as depicted at decision block 210. If an on-hook user goes into an off-hook state, the process gives the on-hook user indication that service is unavailable, as illustrated at block 212. In one embodiment of the present invention, this indication of service unavailability may be the absence of a dial tone. In other embodiments of the present invention, some other form of indication may be used, such as a fast busy signal or an indicator light on or near the on-hook user's terminal equipment unit.

After indicating service unavailable to the on-hook user, the process continues to process the call for the off-hook user, as depicted at block 214. The process then determines whether or not the off-hook user has terminated the current call, as illustrated at decision block 216. If the current call has not been terminated, the process iteratively loops to block 210, wherein the process looks for an on-hook user that has recently gone off-hook.

If the off-hook user has terminated the current call, the process reconnects all users to the transceiver, as depicted at block 204, and then returns to block 202 to detect the next user that goes off-hook.

In summary, the method and system of present invention provides a means for operating multiple terminal equipment units using a single fixed wireless terminal having a single transceiver. The present invention divides, the expense of the transceiver among all terminal equipment units served by the transceiver, thus providing cheaper local loop service per terminal equipment unit compared with a single-line fixed wireless terminal. In addition, the terminal equipment units connected the multi-line fixed wireless terminal operate privately because all terminal equipment units other than the first terminal equipment unit that seizes the local loop are disconnected from the active local loop.

With regard to customer billing, users connected to the multi-line fixed wireless terminal may be billed separately because the multi-line fixed wireless terminal of the present invention is able to distinguish users off the multi-line fixed wireless terminal and transmit billing information that identifies the user making a phone call.

While the examples discussed in the detailed description above provide connections for two terminal equipment units, the principles of the method and system of the present invention may be extended to connect N number of terminal equipment units to a single transceiver fixed wireless terminal.

The foregoing description of a preferred embodiment of the invention has been presented for the purpose of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Obvious modifications or variations are possible in light of the above teachings. The embodiment was chosen and described to provide the best illustration

of the principles of the invention and its practical application, and to enable one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly, legally, and equitably entitled.

Claims

What is claimed is:

1. A method in a telecommunications system for operating multiple terminal equipment units using a fixed wireless terminal having a transceiver:

detecting an off-hook condition in a first terminal equipment unit coupled to said transceiver in said fixed wireless terminal; and

in response to detecting said off-hook condition, uncoupling a second terminal equipment unit from said transceiver, wherein said first terminal equipment unit is private with respect to said second terminal equipment unit.

2. The method for operating multiple terminal equipment units using a fixed wireless terminal according to claim 1 wherein said detecting step includes detecting loop current in a circuit connected between said first terminal equipment unit and said fixed wireless terminal.

3. The method for operating multiple terminal equipment units using a fixed wireless terminal according to claim 1 further including the steps of:

detecting an on-hook condition in said first terminal equipment unit; and

in response to detecting said on-hook condition, recoupling said second terminal equipment unit to said transceiver.

4. The method for operating multiple terminal equipment units using a fixed wireless terminal according to claim 1 further including the steps of:

coupling a plurality of terminal equipment units to said transceiver;

detecting an off-hook condition in any of said plurality of terminal equipment units;

identifying an off-hook unit in said plurality of terminal equipment units; and

indicating an identity of said off-hook unit to said fixed wireless terminal.

5. An apparatus in a telecommunications system for coupling multiple terminal equipment units to a fixed wireless terminal comprising:

first and second input ports;

an output port;

a first communication circuit coupled between said first input port and said output port;

a second communication circuit coupled between said second input port and said output port;

an off-hook detector coupled to said first communication circuit;

a switch coupled to said off-hook detector and coupled in series with said second communication circuit for opening said second communication circuit in response to said off-hook detector.

6. The apparatus for coupling multiple terminal equipment units to a fixed wireless terminal according to claim 5 further comprising an off-hook line indicator having an input coupled to said off-hook detector and an output coupled to said output port for providing a signal that distinguishes an off-hook condition on said first communication circuit from an off-hook condition on any other communication circuit.

7. The apparatus for coupling multiple terminal equipment units to a fixed wireless terminal according to claim 5 wherein said first and second communication circuits emulate plain old telephone service subscriber loops.

8. A multi-line fixed wireless terminal comprising:

a transceiver adapted to communicate wirelessly with a base station transceiver connected to a public switched telephone network;

first and second terminal equipment ports;

a first communication circuit connecting said first terminal equipment port with said transceiver;

a second communication circuit connecting said second terminal equipment port with said transceiver;

a switch connected in series with said second communication circuit that is responsive to a signal at a switch control input; and

an off-hook detector coupled to said first communication circuit having an output coupled to said switch control input for producing said signal.

9. The multi-line fixed wireless terminal according to claim 8 further comprising:

a controller coupled to said transceiver; and

an off-hook line indicator having an input coupled to said off-hook detector and an output coupled to said controller for providing a signal that distinguishes an off-hook condition on said first communication circuit from an off-hook condition on any other communication circuit.

10. The multi-line fixed wireless terminal according to claim 8 wherein said first and second communication circuits emulate plain old telephone service subscriber loops.

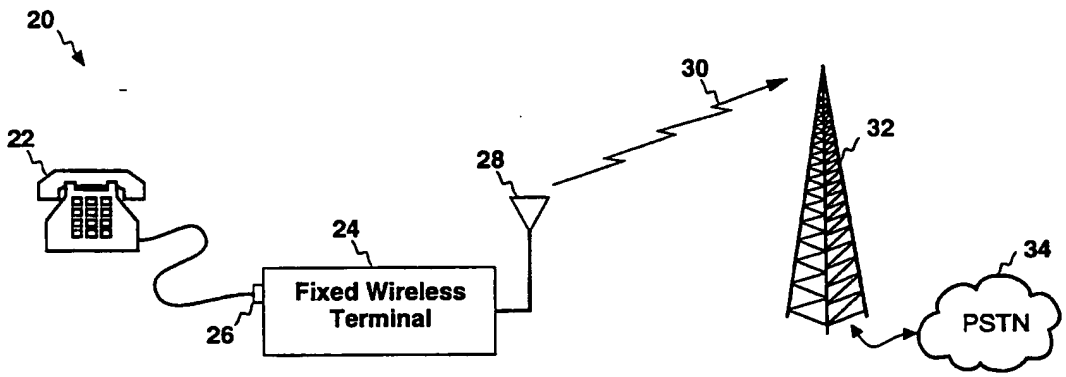

FIG. 1
PRIOR ART

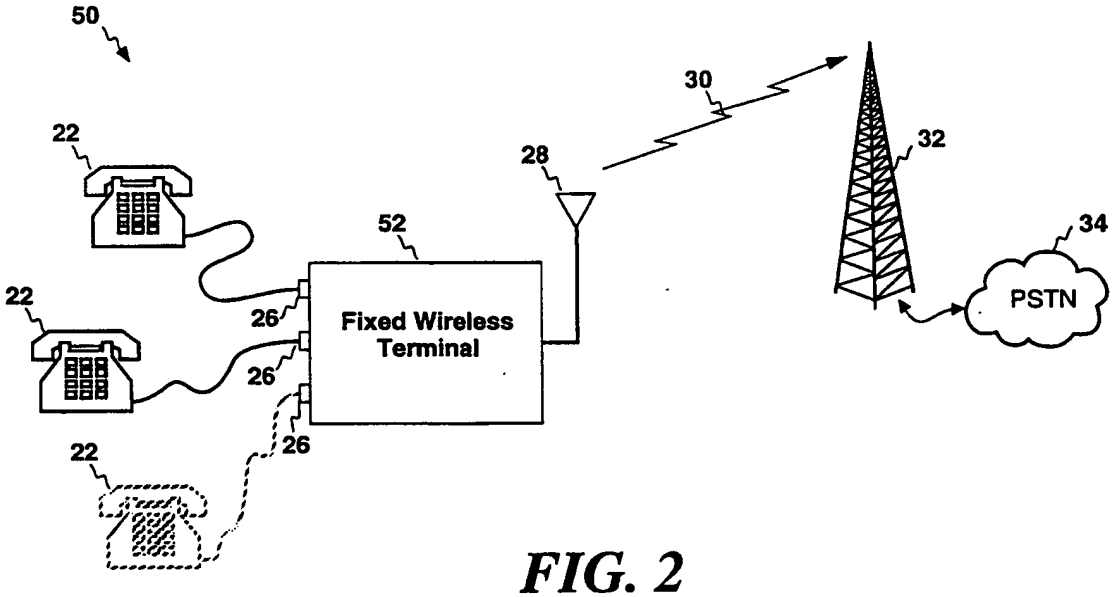

FIG. 2

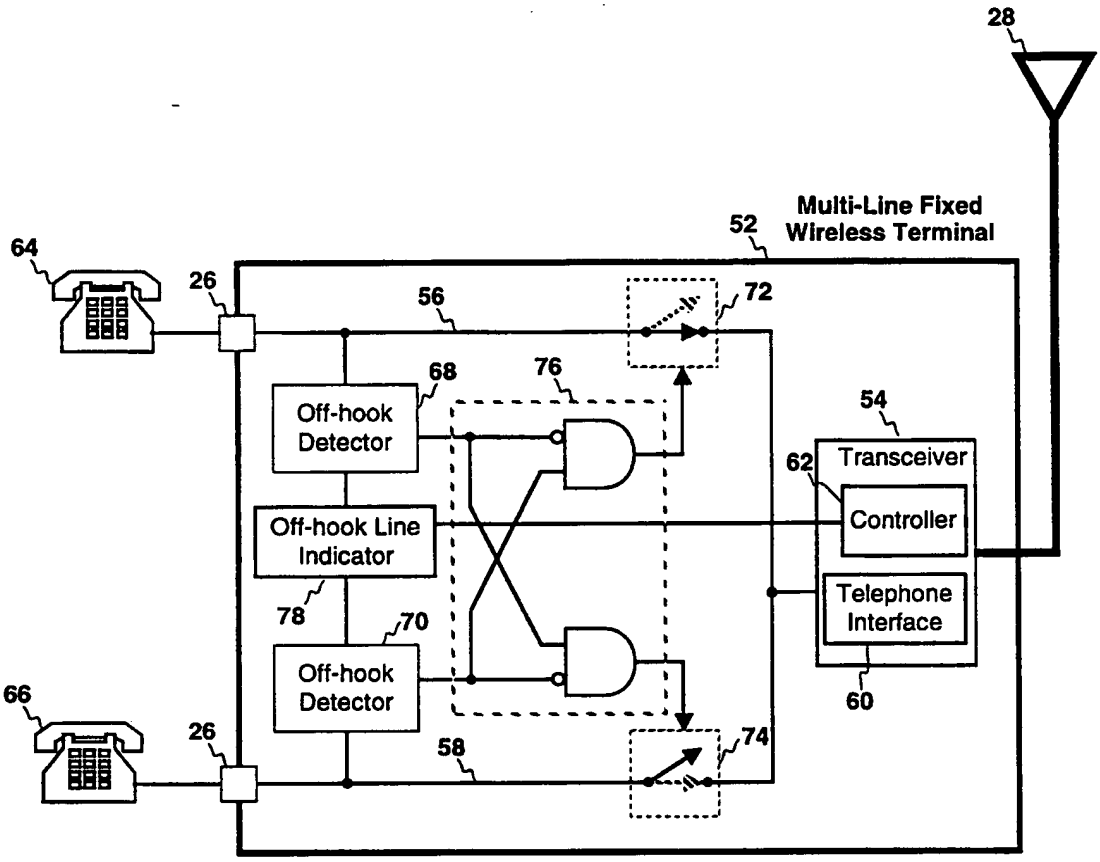
28
Multi-Line Fixed
Wireless Terminal
52
64
26
56
72
68
76
54
Off-hook
Detector
62
Transceiver
Off-hook Line
Indicator
Controller
78
70
Telephone
Interface
Off-hook
Detector
60
66
26
58
74

FIG. 3

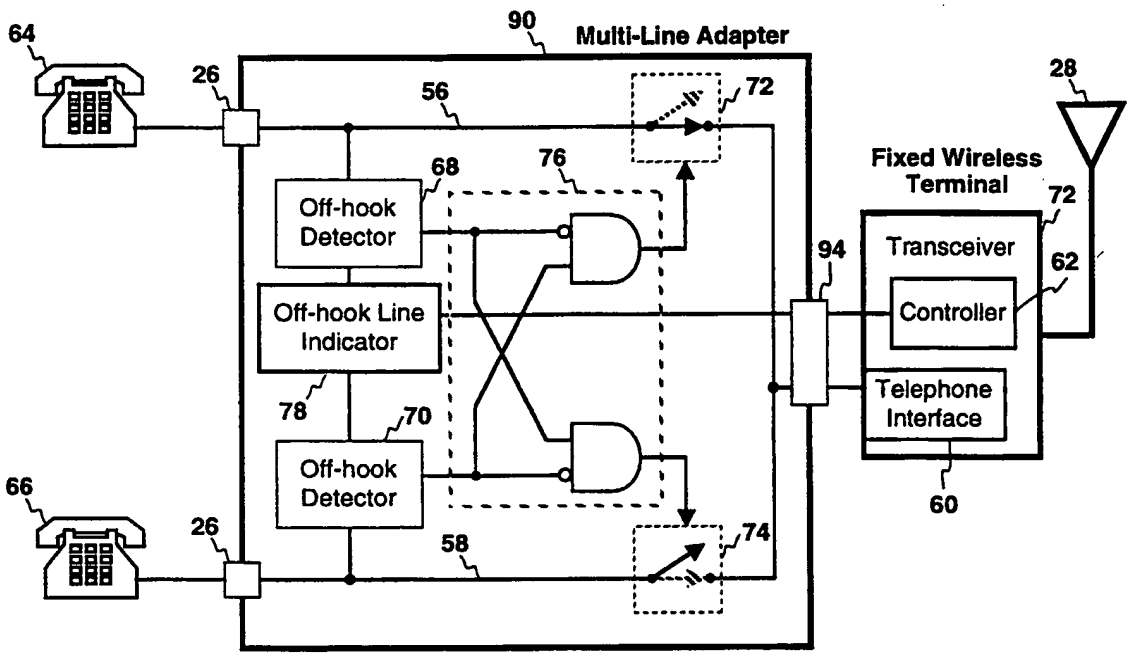
64
90
Multi-Line Adapter
26
56
72
28
Fixed Wireless Terminal
68
76
Off-hook Detector
72
Transceiver
94
62
Off-hook Line Indicator
Controller
Telephone Interface
78
70
Off-hook Detector
66
26
58
74
60

FIG. 4

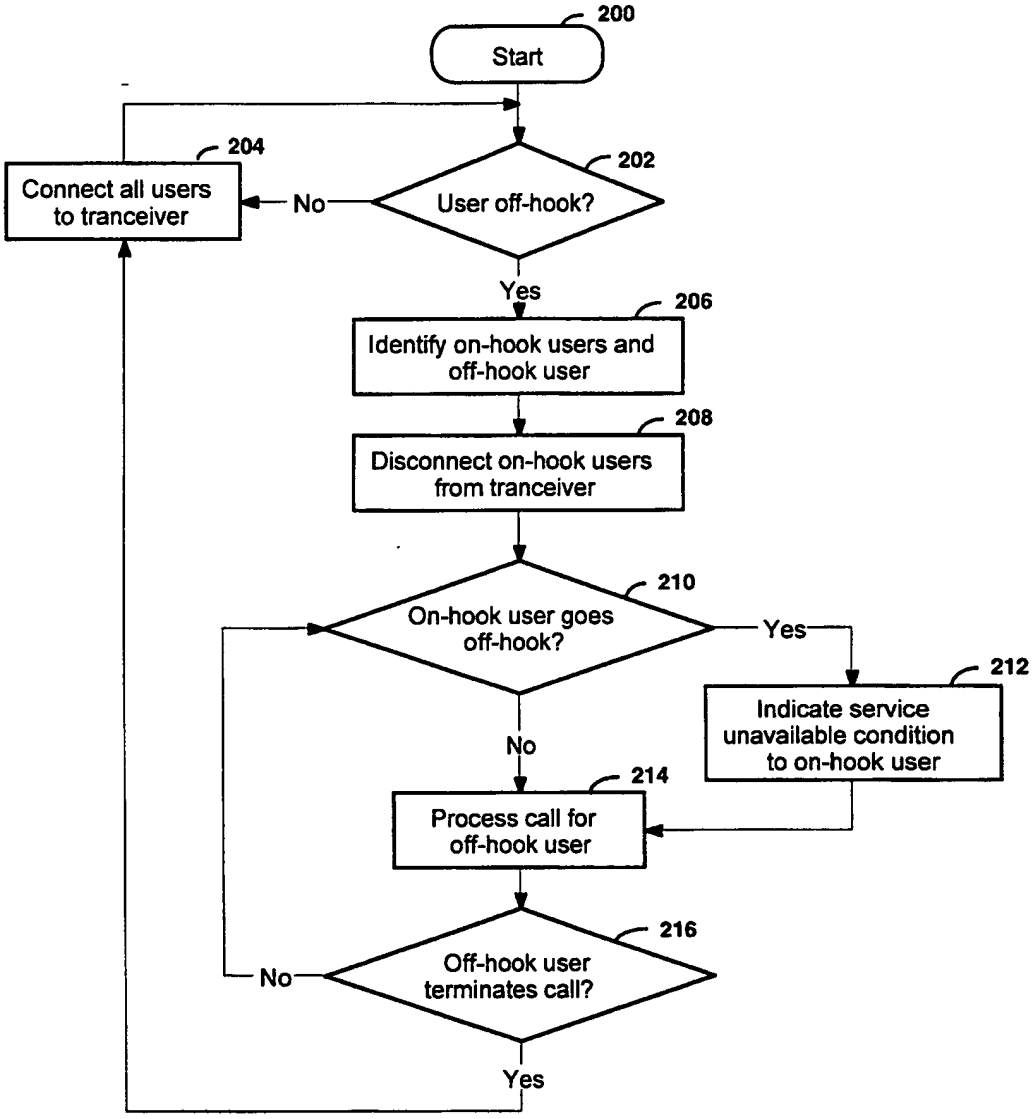
200
Start
202
User off-hook?
No
204
Connect all users to tranceiver
Yes
206
Identify on-hook users and off-hook user
208
Disconnect on-hook users from tranceiver
210
On-hook user goes off-hook?
Yes
212
Indicate service unavailable condition to on-hook user
No
214
Process call for off-hook user
216
Off-hook user terminates call?
No
Yes

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/00169

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :H04M 1/00
US CL : 379/161, 455/411
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 379/161, 167, 168, 184; 455/411

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,559,873 A (Wood et al.) 24 September 1996, col. 1, lines 60-66.	1-10
Y	US 5,311,571 A (Pickert) 10 May 1994, fig. 2, col. 4, lines 15-43.	1-10
Y	US 4,941,166 A (Waldman et al.) 10 July 1990, fig. 6, col. 2, lines 33-38.	1-10
Y	US 4,805,210 A (Griffith, Jr.) 14 February 1989, fig. 1, col. 6, lines 4-12.	1-10

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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